SECTION 5.0 – DETAILED CAD CELL DREDGING DISPOSAL EVENT MODELING AND HYDRODYNAMIC ANALYSES

5.0 DETAILED CAD CELL DREDGING DISPOSAL EVENT MODELING AND HYDRODYNAMIC ANALYSES

The conceptual approach taken for the preliminary dredged material transport modeling in the Harbor was sufficient for the initial general purposes of the DEIR in the MEPA process. For the two preferred alternative confined aquatic disposal (CAD) cells in the DEIR, CI and PIN baseline hydrodynamics information was collected from historical databases for conceptual hydrodynamic analyses. This historical data was considered inadequate for the modeling requested by the MEPA Certificate in response to the DEIR. The MEPA Certificate concurred with the DEIR on the need for a detailed CAD cell dredging disposal event modeling and hydrodynamic analyses for this FEIR. The MEPA Certificate states that if the site-specific information indicates the preferred alternative, in whole or part, is not suitable, the FEIR will provide the same level of information on any alternative site or methodology that might be chosen. Since the CI CAD site area was found less satisfactory than the PIN CAD site area, the PIN CAD area was selected for detailed study (Section 4.0 of this FEIR). Therefore, site-specific detailed CAD cell dredging disposal event modeling and hydrodynamic analyses was applied to the PIN site.

A series of computer simulations was performed to estimate the water quality from dredging and disposal operations at the PIN site. Computer models BFHYDRO (Boundary Fitted Hydrodynamic model), SSFATE (Suspended Sediment FATE model), STFATE (Short-Term FATE dredged material disposal model) and BFMASS (Boundary Fitted Mass Transport model), were employed for hydrodynamic, dredging and disposal modeling, respectively.

This PIN area study consisted of two parts: 1, a field program to monitor present conditions was presented in Section 3.0 (Appendix J) and 2, extension of previous modeling that characterized the transport and fate of the dredged sediment and associated pollutants during disposal operations (Appendix K).

As presented in Section 3.0, physical field data that included surface elevations and velocities at multiple sites were examined to quantify wind and tide forces that drive the circulation in the Harbor. Hydrodynamic simulations were conducted to verify the model performance during the period of the field measurement program. Then a set of simulations was performed, based on the combination of three tidal ranges (neap, mean and spring) and three wind conditions (calm, southwesterly [SWS] and northwesterly [NWW]). These nine hydrodynamic conditions were used to provide three-dimensional velocity predictions to the pollutant and sediment transport model both before and after excavation of the CAD facility.

Presented in this Section 5.0, the SSFATE model was used to simulate TSS (Total Suspended Solids) concentrations due to construction excavation of the proposed CAD cells to be located north of Popes Island and disposal operations into the cells. Combinations of the wind-induced circulation and bathymetry were found to play a key role. When the sediment plumes were carried into the deeper sections of the Harbor, the duration and size of sediment cloud were more extensive than the case in which the sediment plumes were carried into shallower sections, where the sediment settled to the bottom more quickly.

A series of pollutant fate and transport simulations were performed to estimate the water quality impacts using BFMASS. Simulations were run using measured pollutant levels found at six representative sites for constituents whose elutriate concentrations exceeded the U.S. EPA water quality criteria. These included metals (aluminum, copper, nickel and silver), and polychlorinated biphenyls (PCBs). The dredged material disposal operation was assumed to last for 6 days with disposal taking place twice a day following the tidal cycle period of 12.42 hrs. Each release volume of dredged material was assumed to be 1,530 m^3 (2,000 yd^3), a possible barge capacity suited for moderate volume projects.

None of pollutant elutriate concentrations exceeded the U. S. EPA water quality acute criteria except copper (4.8 ug/L) at two stations. Al, Cu, Ni, Ag, and PCB exceeded chronic levels at all stations. The dilution of elutriate concentration for PCB to meet the chronic criteria ranged between 11 and 767, Cu had the next highest required dilutions (1 to 32) followed by Al (2 to 27), Ag (14) and Ni (2). One proposed site, Station NBH-202 had the highest concentrations for all constituents. Station NBH-207 was second highest.

The BFMASS simulation results indicated that the contaminant distribution patterns in the horizontal and vertical were similar for the three tide ranges; neap mean and spring. Neap tides are the highest low and the lowest highs equating to the smallest tidal range. Mean tides are normal tides. Spring tides are extreme lows and extreme highs equating to the largest tidal range. Concentration levels, however, were higher in the near field for neap tides than for spring tides because more energetic currents during the spring tides promote more dispersion and mixing. Different wind conditions resulted in different spatial distribution patterns and coverages. Among the nine environmental scenarios, the largest spatial coverage (area) was predicted for neap tides and calm wind conditions. The smallest coverage occurred for neap tides and northwesterly winds. This finding was consistent among three different release locations in the high capacity PIN CAD cell.

According to toxicity tests using sediments from the NBH-202 station, the combination of multiple pollutants was the cause of the observed acute toxicity effects. For example, half the toxicity to mysids was due to PCBs and the other half was due to a combination of copper and ammonia. From analysis of these results it was concluded that a dilution to less than 2.2% of the elutriate concentration would be protective. The model results showed that for any environmental condition, area coverage for a concentration of 2.2% of the elutriate level was always smaller than the PIN-CAD area (1.67×10^5 m^2 [41 ac]). The largest area coverage (1.2×10^5 m^2 [30 ac]) of the 2.2% elutriate concentration occurred for a release during calm conditions while the smallest coverage (1.0×10^4 m^2 [2.5 ac]) occurred for a release during northwesterly winds. Other sediments with lower elutriate concentrations, and presumably lower toxicity, will affect smaller areas.

5.1 Background

The field program was conducted for the analysis of both CI and PIN CAD site areas from 23 October through 22 November 2002. (See Appendix J). The field program and data were supportive of both Preferred Alternative CAD sites. Detailed hydrodynamic modeling of resusspended sediment was directed to the PIN CAD cell site as the Selected Alternative in the FEIR (See Appendix K).

Data considered here derive from a field survey conducted for this FEIR in the Harbor from 23 October through 22 November 2002. Current speed and direction, surface elevation and optical backscatter were measured continuously throughout the study period at two locations in New Bedford Harbor: the CI and PIN stations (Figure 5-1, Table 5-1). This was accomplished through the deployment of Acoustic Doppler Current Profilers (ADCPs) and Acoustic Doppler Current Meters (ADCMs) at each of these two locations. Surface elevation and optical backscatter were also monitored at the Tide Gauge (TG) station, located outside the Harbor, using a tide gauge and an Optical Backscatter Sensor (OBS). In addition to the long-term instrument deployments, a series of water samples was taken at each of the three stations mentioned above to measure suspended sediment concentrations. Sediment samples were obtained from seventeen locations within the study area and analyzed to provide sediment grain size composition (Section 3-5). Finally, elutriate analyses were performed on sediment samples from three locations at the proposed CI CAD site, two locations at the proposed PIN CAD site, and one location northwest of Fish Island in the Inner Harbor to determine levels for a number of pollutants (Section 3-8).

5.1.1 Total Suspended Sediments

Optical backscatter are data collected by electronic reflections of particles suspended in the water column moving in current strata. Optical backscatter was measured at 15-minute intervals continuously at each of the three long-term deployment stations using D+A Optical Backscatter Sensors (OBSs). Measurements of optical backscatter were generally low, averaging 2.7 (Nephelometric Turbidity Units (NTU) at PIN, 9.1 NTU at CI and 4.3 NTU at the TG station. In order to relate optical backscatter to sediment levels in the water column, measurements of total suspended sediment (TSS) concentrations were made at the three station locations on five occasions during the study period (Table 5-1). Multiple samples were taken at a height of approximately 1 m (3.3 ft) above the seafloor on each occasion.

Table 5-1. Total suspended sediment-sampling schedule. Times are given as Local Standard Time (LST).

	Date				
Site	**23 Oct**	**1 Nov**	**7 Nov**	**14 Nov**	**22 Nov**
Popes Island	9:50	8:58	13:50	8:50	11:30
Channel Inner	11:50	9:15	13:00	9:10	9:38
Tide Gauge	11:00	9:30	15:00	9:30	8:50

5.1.2 Chemistry

Elutriate tests are typically performed to estimate the release of soluble contaminants during dredging operations for setting operations parameters in permits. In elutriate tests, a combination of 20% sediment and 80% site water is mixed and allowed to settle. The liquid component is then analyzed for contaminant concentrations. This protocol was designed to accurately mimic the initial concentration levels when sediments are released in the water column (Averett, 1989). Elutriate analyses were performed on samples from six stations within New Bedford Harbor to determine background pollutant levels for resusspended sediments (Table 5-2) and reported in Section 3-8 Water Column Chemistry. Aluminum, copper, nickel, silver and Total PCBs registered above the chronic exposure levels established by the United States Environmental Protection Agency (EPA) at all sites for which analyses were performed. Lead exceeded chronic exposure levels at the NBH-202 station, Benzo(b)fluoranthene exceeded chronic exposure levels at the NBH-202 and NBH-207 stations, and Benzo(k)fluoranthene exceeded chronic exposure levels at NBH-202, NBH-205, NBH-206 and NBH-207. In addition, acute exposure levels were exceeded for aluminum at NBH-202 and NBH-207, and for copper at NBH-201, NBH-202, NBH-205, NBH-206 and NBH-207. Stations NBH-202 and NBH-207, the Fish Island site, showed generally higher concentrations than the other sites.

Table 5-2. Results of elutriate analyses from the NBH Water Quality Study. Values given in bold red italics exceed chronic exposure levels as established by the EPA (chronic and acute values are listed to the right).

		Station (NBH-)												EPA Criteria	
Class	**Analyte**	**201**		**202**		**204**		**205**		**206**		**207**		**Chronic**	**Acute**
MET	Aluminum	***161***	B	***2320***		***577***		***346***		***216***		***853***		87	750
MET	Antimony	3.50	U	3.50	U	3.50	U	3.50	U	3.50	U	5.80	B		
MET	Arsenic	5.20	B	18		3.80	B	24		13		5.10	B	36	69
MET	Cadmium	0.30	U	0.45	B	0.30	U	0.30	U	0.30	U	0.30	U	9.3	43
MET	Chromium	4.60	U	35		4.60	U	4.60	U	4.60	U	10		50	1100
MET	Copper	***7.10***	B	***98***		***4.00***	B	***11***	B	***7.10***	B	***39***		3.1	4.8
MET	Iron	214		2630		587		218		212		995			
MET	Lead	1.10	U	***13***		1.10	U	1.10	U	1.10	U	1.10	U	8.1	220
MET	Manganese	2.50	U	2.50	U	27		2.50	U	2.50	U	2.50	U		
MET	Mercury														
MET	Nickel	***14***	U	***14***	U	***14***	U	***14***	U	***14***	U	***14***	U	8.2	74
MET	Silver	***1.40***	U	***1.40***	U	***1.40***	U	***1.40***	U	***1.40***	U	***1.40***	U	0.1	1.9
MET	Zinc	6.90	U	40		6.90	U	6.90	U	6.90	U	16	B	81	90
PAH	Benzo(b)fluoranthene	0.02	J	***0.14***		0.02	J	0.03		0.04		***0.11***		0.04	0.38
PAH	Benzo(k)fluoranthene	0.02	J	***0.14***		0.01	J	***0.03***		***0.03***		***0.07***		0.02	0.17
PCB	Total PCBs	***1.72***		***23***		***0.34***		***0.88***		***1.22***		***5.69***		0.03	10

Units: µg/L.
Data Qualifiers: "B" (metals) ≤ Contract Detection Limit but > Instrument Detection Limit; "J" = estimated (result is between 1/2 reporting limit (RL) and RL); "U"=not detected above reporting limit.
Total PCBs - Sum PCB congeners (8, 18, 28, 44, 52, 66, 101, 105, 118, 128, 138, 153, 170, 180, 187, 195, 206, 209) x 2; list of congeners analyzed by NOAA Status and Trends Program (listed in NOAA, 1993; revised NOAA, 1998).

5.2 Dredged Material Modeling Using SSFATE

5.2.1 Sediment Characteristics Near the CAD Cell Site

One of the major factors that controls TSS concentration is how fast the sediment settles from the water column back to the bottom. In general, coarser materials have higher settling velocities while the finer materials stay in the water column much longer. By examining size fractions of sediment for the site, basic settling characteristics can be determined. The SSFATE model treats sediments as having five distinct size classes (Johnson, et. al., 2000).

Table 5-3. SSFATE sediment size classes.

Class	Size (micron)	Description
1	0 – 7 micron	clay
2	8-35	fine silt
3	36-74	medium fine silt
4	75-130	fine sand
5	>130	coarse sand

5.2.2 Predicted TSS Concentrations

SSFATE simulations that represent CAD cell excavations using clamshell bucket dredging were performed for the nine typical hydrodynamic conditions described above. The center coordinate of the largest CAD cell, Cell 1was designated as a representative dredging operation location, which was fixed for the duration of the simulation. TSS concentration distributions due to the clamshell dredging reached a quasi-steady state within two tidal cycles (~1 day). All simulations were run for 3 days.

Presentation of simulation results are shown by:

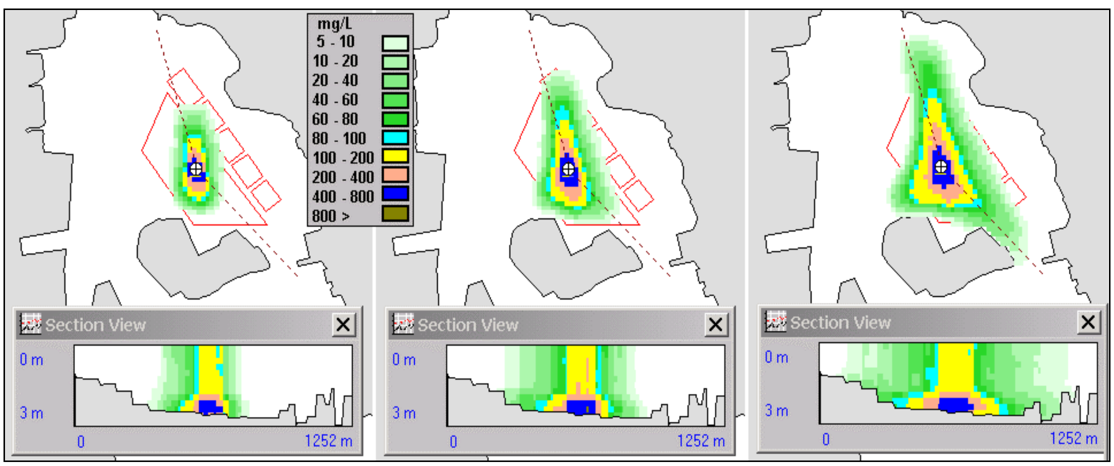
- Horizontal and vertical views of TSS concentration distribution
- Acreage of the area exceeding various concentration levels
- Sediment mass balance

Figure 5-1 shows contours of the maximum TSS concentrations throughout the water column over the 3-day simulation period. A vertical section of the concentration distribution was inserted at the base of each plan view. Frames in the figure are organized such that rows display simulations for the three wind conditions and columns for the three different tides. See Appendix N for quantitative comparisons.

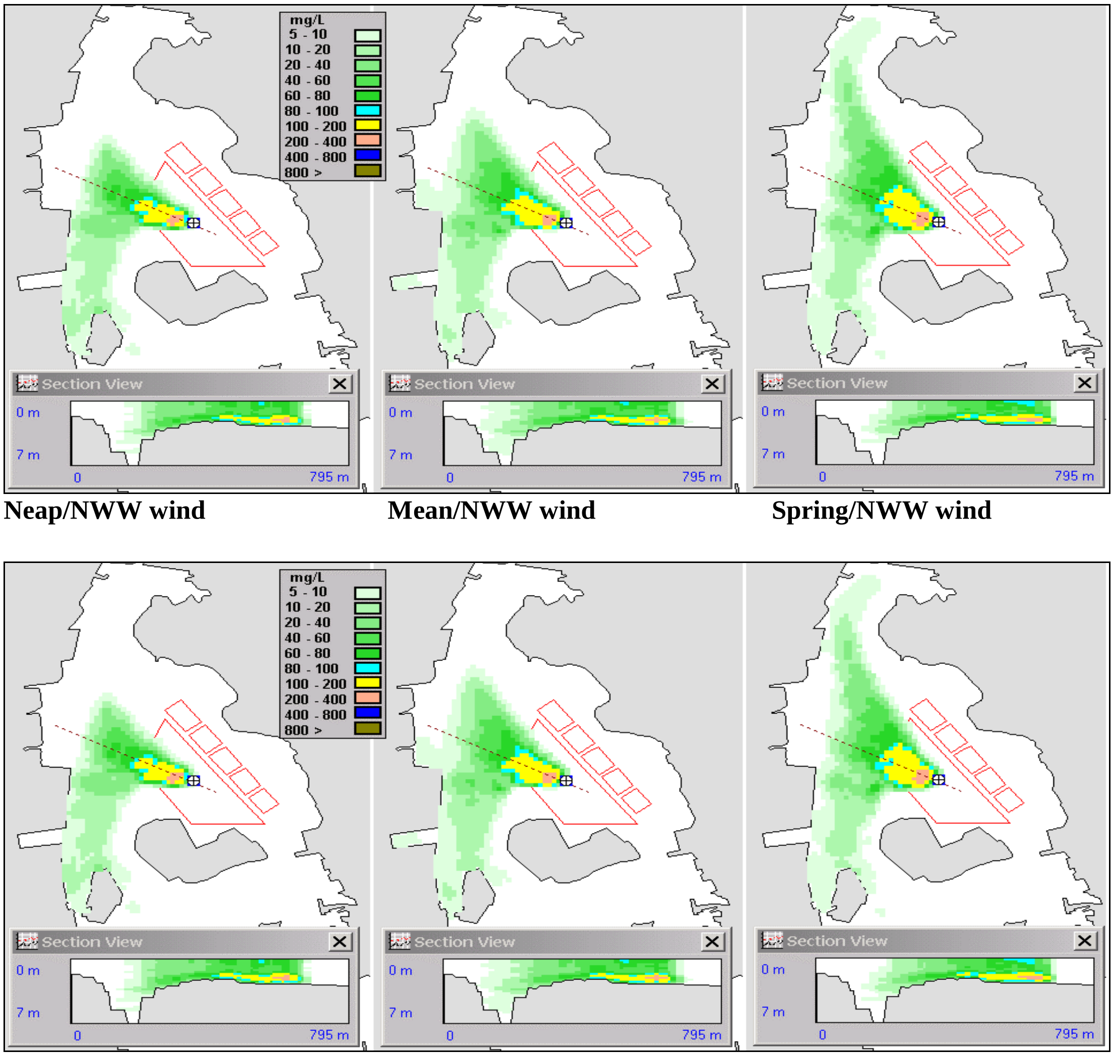
For the neap tides only condition (1st row), all TSS distributions appeared to be centered in the dredge site. Overall sediment plume sizes correspond to the tide strength. For the NWW wind cases, all sediment plumes trail to the lee side of the wind direction, whereas the opposite is found for the SWS wind cases. Similar results are obtained for mean and spring tidal conditions, except the size of plume increases with increasing tide range.

It is important to note that the instantaneous concentrations, which vary widely in time, are significantly smaller than the maximum TSS concentrations presented here. Neap tide also results in smaller areas and spring tide results in larger areas than the mean tide. The analysis presented here did not include the ambient or background TSS concentrations that were sampled during the field program and typically ranged from 3 to 10 mg/L.

Figure 5-2 presents the mass of the fine fractions of sediment remaining in the water column after all settling has occurred. When the system reaches a quasi-steady state, the sediment mass introduced by dredging equals the mass that settles out, so the fraction of sediment that remains waterborne becomes constant. This water column sediment fraction is uniquely distributed by overall size and concentration among the hydrodynamic conditions. For example, the water column sediment fractions in the NWW case and SWS case are ~2% and ~3%, respectively. This number indicates that the SWS case produces a larger sediment plume and a higher sediment fraction remaining in the water column, compared to the NWW case. This is caused by advection carrying sediments to the deeper waters, in contrast to the NWW case, in which sediments are transported to shallow water where faster settling takes place. In the case of calm wind conditions, the higher tide conditions have the higher water column sediment fraction.



Neap/Calm wind **Mean/Calm wind** **Spring/Calm wind**



Neap/NWW wind **Mean/NWW wind** **Spring/NWW wind**

Neap/SWS wind **Mean/SWS wind** **Spring/SWS wind**

Figure 5.1. Maximum TSS concentrations for the nine circulation scenarios. Section inserted.

The reason is not obvious. However, there are two possible explanations: 1) the smaller tide range tends to form higher sediment concentrations, which in turn enhance the aggregative settling, 2) the lower tidal current (lower velocity) provides higher deposition probability.

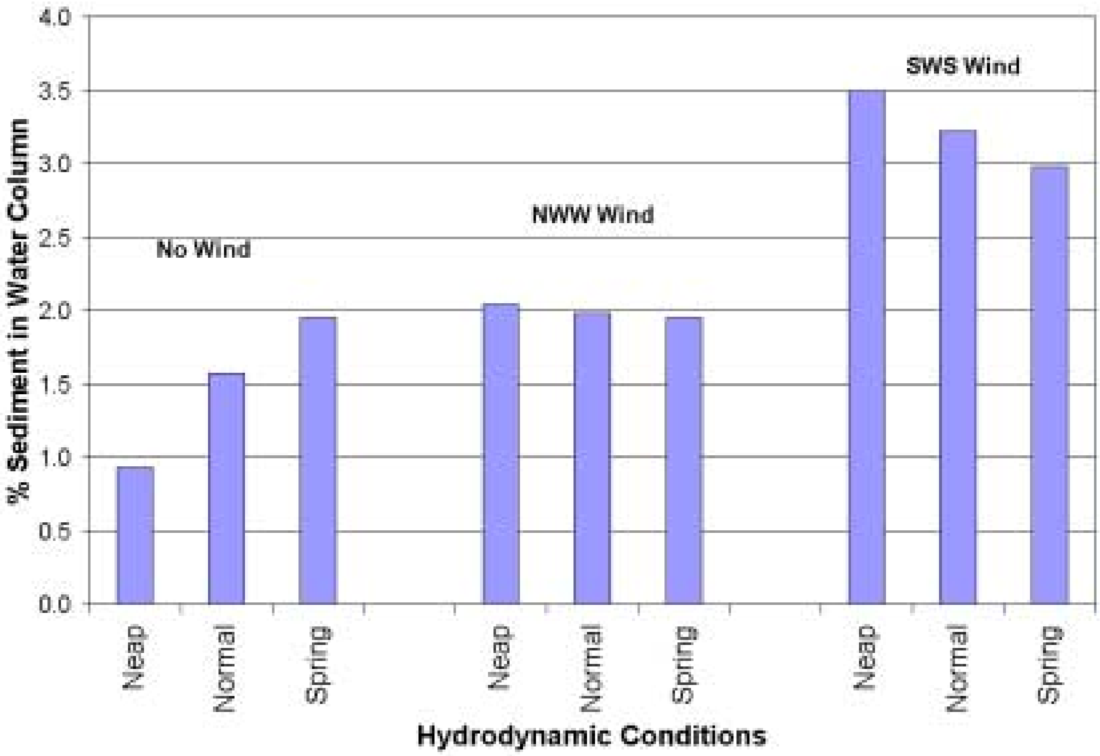


Figure 5-2. Sediment fractions in water column for various hydrodynamic conditions

5.2.3 Single Event Disposal into Popes Island CAD Cell

In the previous section, TSS increases due to sediments in the water column from repetitive clamshell bucket operation were simulated. In this section, TSS concentration increases due to sediment disposal from a scow into the CAD cell are presented. Sediments dredged from the top layer of PIN CAD cell(s) will be stowed in barges until the CAD cells are fully dredged when they will be released into the CAD cell(s). Other unsuitable sediments dredged for channel maintenance and improvement projects are planned to be placed in a scow after the clamshell bucket removes sediments from the seafloor. When these scows are considered loaded by operations managers, they will be shipped from the dredging site to a predetermined specific location above the specifically designated CAD cell. When in the proper location, operators open the scow bottom to release the entire payload. As the sediment descends to the CAD cell floor, approximately 15% of the sediment remains suspended unevenly in the water column (see Table 5.4). The occurrence of those scow-load disposal events is controlled by the clamshell dredging speed of 214 m^3/hr (280 yd^3/hr) and the scow capacity of 1,530 m^3 (2,000 yd^3). At this rate, a scow-load disposal event will occur every ~12 hours. The approach to simulate TSS concentrations caused by a single scow disposal follows the same procedure employed in the previous section.

5.2.4 Source Strength Estimation Due to Scow Disposal Events

Although excavated CAD cells have much deeper water depths (~17 m [56 ft]) than the original undisturbed depth (~2.6 m), the time for most of the sediment to reach the bottom is still very short (< 120 sec). This short time span cannot be directly simulated by SSFATE. Instead, the USACE model STFATE (Short-Term Fate dredged material disposal model) was used with equivalent input and environmental conditions. STFATE has various operational modes. Convective descent and sediment cloud collapse phase were simulated. This output was used to estimate initial source strengths and vertical distribution of waterborne unsuitable sediment mass.

The estimated stripped portion of the sediment that remains near the surface in the water column during descent has been estimated to be 1% of total sediment in the bucket (ENSR, 2002). Clamshell-dredged, cohesive material has a high proportion of clump content that tends to reach the bottom intact. This stripped loss estimate is comparable to those used in similar CAD cell projects in Providence and Boston. The vertical distribution of waterborne sediment mass predicted from the STFATE model is given in Table 5.4. Most (85%) of the material immediately falls to the bottom.

Table 5.4. The vertical distribution of waterborne sediment mass.

Percent of water column	Percent of sediment mass
90 (near surface)	1
70	2
50	4
30	8
10 (near bottom)	85

5.2.5 Sediment Characteristics of Dredged Materials

Figure 5-3 shows locations of the sediment samples obtained from the CI CAD cell site exemplary of maintenance-dredged materials in the New Bedford Harbor Plan. Some of the dredging is expected to take place at this location. Averaged values of size distributions from these sampling stations were considered to be representative (Table 5.5). The distribution is very similar to PIN.

Table 5.5. Representative sediment size class distribution.

Class	Description	Distribution %
1	Clay	20.1
2	Fine silt	17.7
3	Medium fine silt	17.7
4	Fine sand	20.1
5	Coarse sand	24.5

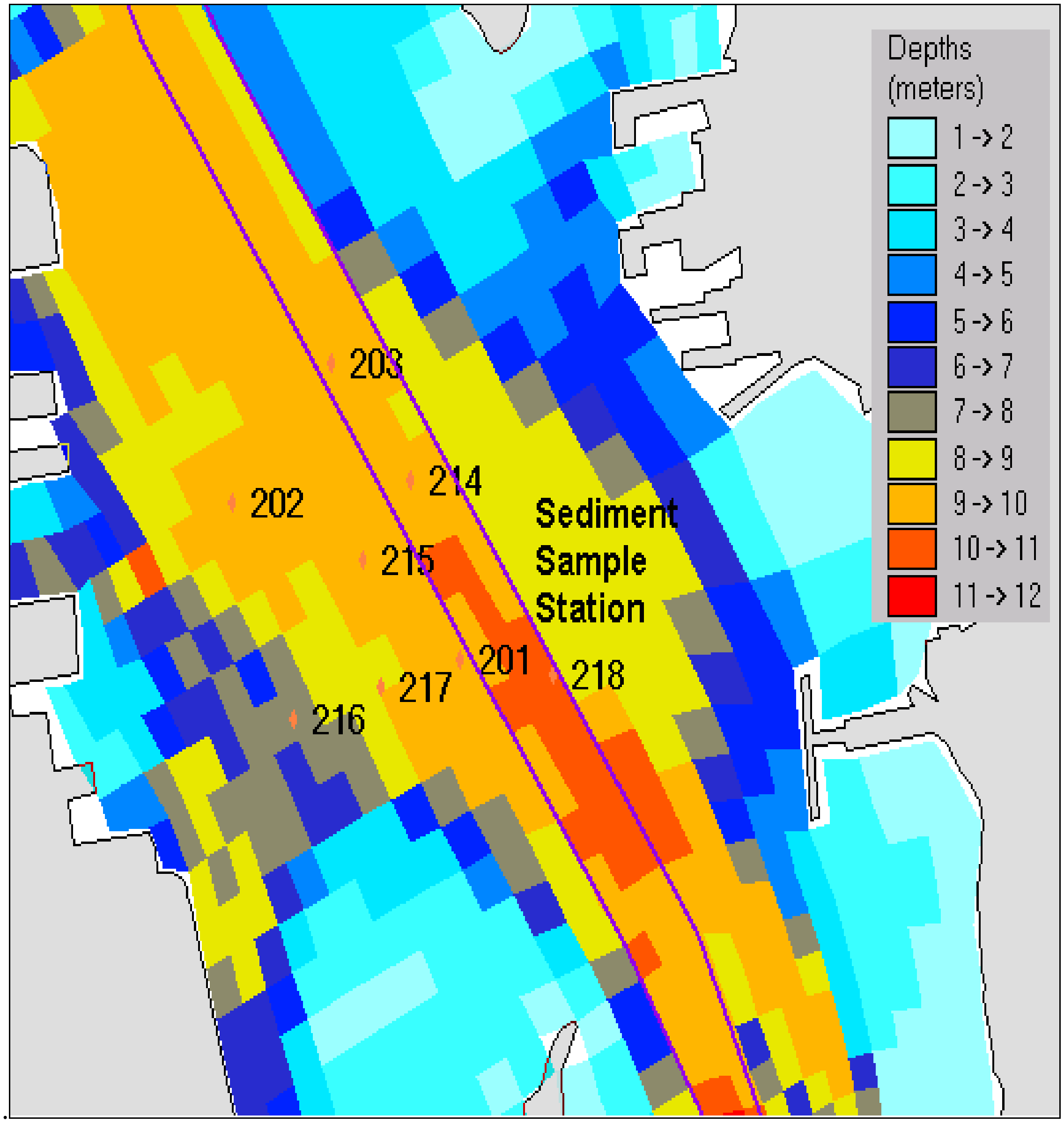


Figure 5-3. Map showing sediment sampling stations near Channel Inner dredge site.

5.2.6 Model Results for Dredged Material Disposal Operation

SSFATE simulations that represented the fate of the dredged material from disposal operations were performed for the nine hydrodynamic conditions. The bathymetry in which the circulation field was created is substantially deeper (~17 m [50 ft]) at the disposal site than the one used (~2.6 m [8.5 ft]) in the previous PIN-CAD cell excavation simulation. The center coordinate of the largest CAD cell was used as the representative disposal site. Unlike the more methodical pace of dredging operations, split-hull scow sediment release is fast. The simulation period was 12 hours.

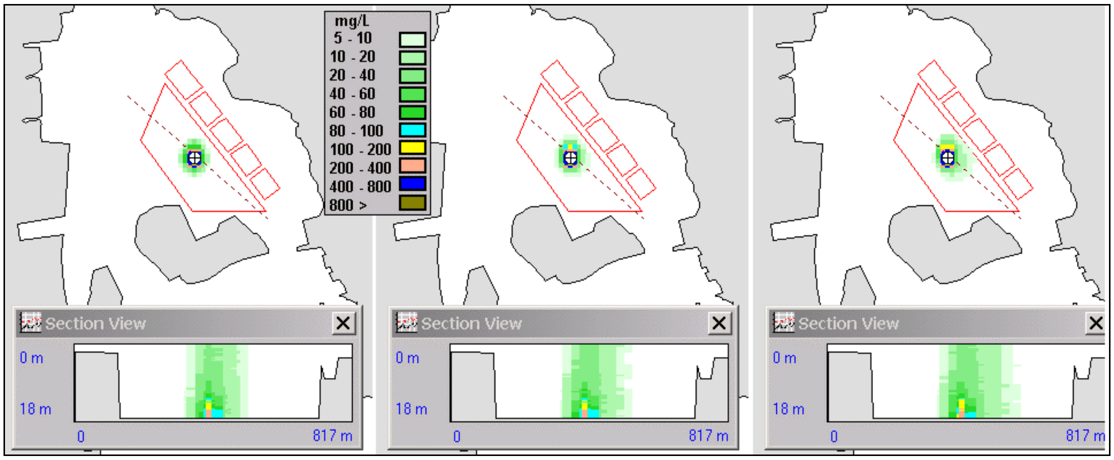
The simulation results presented in this section include:

- Horizontal and vertical view of TSS distribution
- Time series of acreage of exceeding 10 mg/L concentration levels

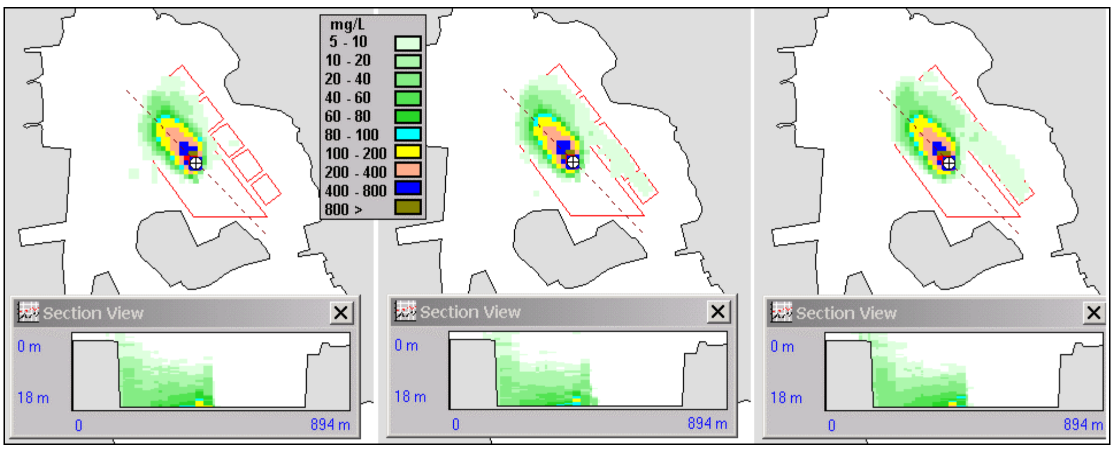
Figure 5-4 shows a plan view of the maximum predicted TSS concentrations throughout the water column during the 12-hour simulation period. Vertical section views of the concentration are inserted in the figure. The frames in the figure are organized by row (wind conditions) and columns (tide conditions). The rows correspond to calm wind, NWW wind and SWS wind from top to bottom, and the columns correspond to neap, mean, and spring tide from left to right.

All TSS concentration distributions for the tide only scenarios were confined within the PIN-CAD cell since the circulation is too weak to transport material very far. For the NWW and SWW wind cases, sediment clouds reach the edge of the CAD cells, although most of the sediment remained in the cell. The direction of sediment drift corresponded to the flow guided by a combination of the surface wind stress and the bathymetry of the CAD cell. The NWW wind case transported the bottom sediment to the northwest and the SWS wind case transported the sediment to the southwest. It is important to note that the instantaneous concentrations, which varied widely in time, were significantly smaller than the maximum TSS concentrations presented here.

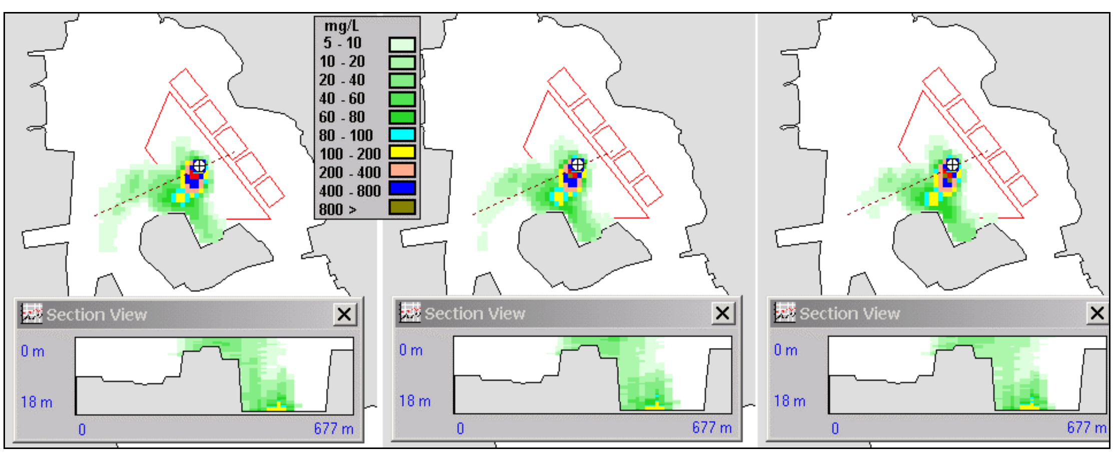
Figure 5-5 shows the area coverage that exceeds a TSS concentration of 10 mg/L (approximately the background threshold) in time. For the case of wind driven circulation, the sediment cloud dissipates within ~ 3 hours. The calm wind tide cases take much longer to settle as most sediment stays in the deep area (~17 m) and so the vertical travel time is increased.



Neap/Calm wind **Mean / Calm wind** **Spring/Calm wind**



Neap/NWW wind **Mean/NWW wind** **Spring/NWW wind**



Neap/SWS wind **Mean/SWS wind** **Spring/SWS wind**

Figure 5-4. Maximum TSS concentrations throughout water column and duration of simulation for the nine hydrodynamic scenarios.

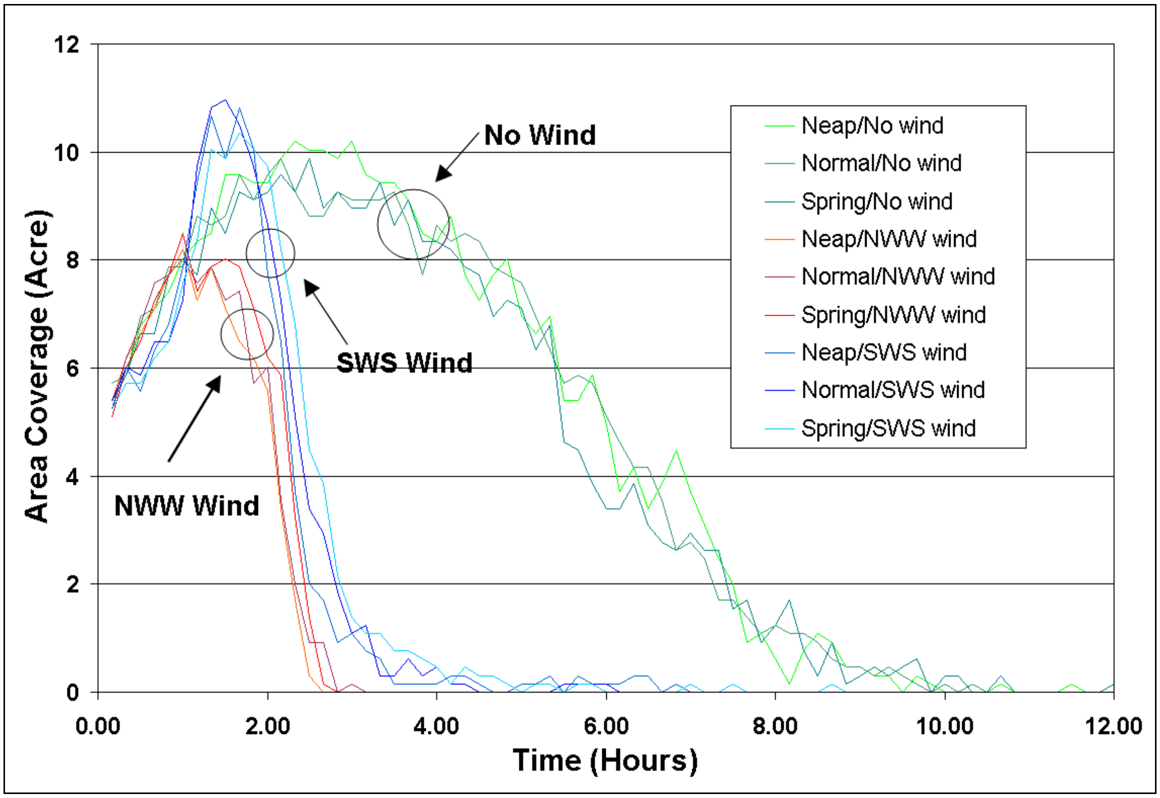


Figure 5-5. Time series of area coverage (acre) (encircled) that exceeds TSS concentration of 10mg/L for the nine hydrodynamic scenarios**.**

5.3 Pollutant Transport Modeling Using BFMASS Model Applications

5.3.1 Disposal Operations

In BFMASS the two- or three-dimensional advection-diffusion equation is solved on the same boundary conforming grid as the hydrodynamic model, BFHYDRO (See Appendix K). There are two types of dredging operations that will use the PIN CAD cell(s) that are classified high and moderate volume projects. Since moderate volume projects are more certain at this time, pollutant transport and fate simulations were focused on disposal activity for a moderate project whose volume is on the order of 30,600 m^3 (40,000 cy). Table 5-6 lists the details of a likely disposal activity in addition to the associated dredging operation for this modeling. These details were developed to best represent moderate volume projects, consistent with intermediate goals of the New Bedford Harbor Plan. It was assumed that two split-hull scows will work in tandem, alternating to haul and dispose unsuitable dredged material during two 12-hr shifts per day. Dimensions of each barge were 3 m (10 ft) wide by 76 m (250 ft) long with a holding capacity of 1,530 m^3 (2,000 yd^3).

Table 5-6. Assumed details for modeling of dredging and disposal operations in New Bedford Harbor.

Operation	Parameter		Detail
Dredging	Dredging Sites		Maneuvering channel, berth, wharf, inner federal navigation channel
	Dredging Project Volume		30,600 m (40,000 yd^3)
	Composition of dredged material (%)	Contaminated material	90
	Types of dredging operation for	Contaminated material	Continuous
	Dredging equipment used for	Contaminated material	Environmental bucket
	Bucket capacity	Environmental bucket	<u>5.4</u> m^3 (7 cy)
	Dredging rate (min/grab)		1.5
	Duration of dredging operation (day)		6
	Number of concurrent dredging operations		One
	Time of dredge operations		1 June 2003 ~ 1 January 2004
	Loss rate during dredging operation		1.5%
Disposal	Disposal Site Location		Popes Island North
	Number of scows		2
	Scow Capacity (cy)		1,530 m^3 (2,000 cy)
	Dimension of scow		3 m (10 ft) wide × 76 m (250 ft) long
	Type of scow		Split-hull
	Duration of disposal operation (sec)		5
	Typical cycle from barge loading to disposal (hour)		12

5.3.2 Source Strength and Settling Velocity

The source strength is the mass of pollutant entering the system from released unsuitable sediments on a rate basis. Three types of source strengths can be specified in BFMASS: 1), an instantaneous release; 2), a constant release over time; and 3), variable release over time. An instantaneous source release is the mass of material released to the water column from an entire split-hull barge load in a second. A constant source is defined as the mean loading to the water column from multiple barge releases over time. A variable source is the time varying loading to the water column as individual barge releases occur according to a time schedule.

The disposal operation of dredged material in New Bedford Harbor is assumed to take place twice a day over a 6-day period for a typical small project (Table 5-6). To simulate the operation, a series of 12 instantaneous releases of a volume of 1,529 m^3 (2,000 yd^3) was assumed to occur once every 12 hours.

A conservative estimate of the mass of pollutant released from the disposal of dredged material can be determined from elutriate analysis data (EPA, 1991). Since elutriate testing was designed to measure the dissolved fraction of pollutant in liquid portion, the mass of pollutant is approximated as the product of the elutriate concentration E and the volume of water (see Section 3-8). The settling velocity acts as a mechanism to remove suspended sediment from the water column.

5.3.3 Release Location

The PIN-CAD facility will be excavated to an average depth between 11.6 m (38 ft) and 17.4 m (57 ft), to accommodate 734,000 m^3 (960,000 cy) of dredged material in a total of 6 cells generated from New Bedford Harbor maintenance dredging projects over the next 10 years. Cell 1 is the highest capacity CAD cell, with potential capacity of 1,408,000 m^3 (1,841,000 cy) of sediment. Cells 2 through 6 are similar in size and each can hold approximately 39,000 m^3 (51,000 cy) volume (Section 3-3). Since the preliminary CAD cell configuration for moderate capacity CAD cells (86 m long by 65 m wide) is slightly larger than a typical model grid cell at the PIN CAD facility, the moderate capacity cell size is too small to accurately simulate. Therefore, simulations of disposal operations will focus on the high capacity Cell 1 (Section 3.3).

Since Cell 1 will be filled progressively, disposal operations were simulated as three separate operations these operations were representative of the continuous activity having release locations at the center, the northwest and southeast corners of the CAD-site (Figure 5-6).

5.3.4 Toxic Pollutants

Simulations of the fate and transport of pollutants were performed on constituents whose elutriate concentrations exceeded U. S. EPA water quality chronic levels. Analysis of elutriate samples in New Bedford Harbor (SAIC, 2003) showed that most of the stations located at dredging and disposal sites contained elevated concentrations of Aluminum (Al), Copper (Cu), Nickel (Ni), Silver (Ag) and Polychlorinated Biphenyls (PCB). Benzo(a)fluoranthene and Benzo(k)fluoranthene, part of high molecular weight (HMW) (Petroleum Aromatic Hydrocarbon), also exceeded the USEPA chronic levels at some stations.

As part of modeling input, the mass of the pollutant source is required for each contaminant. None of pollutants exceed the U. S. EPA water quality acute level except copper (4.8 ug/L) at NBH-202 and NBH-207 stations. Only Al, Cu, Ag and PCB exceed the chronic levels. The dilution elutriate concentration needed for PCB to meet the chronic level ranges between 11 and of 67. Copper has the next highest required dilutions (1 to 32) followed by silver (14). Station NBH-202, has the highest concentrations for all constituents shown in the table. The next highest concentrations are from station NBH-207, located at Fish Island.

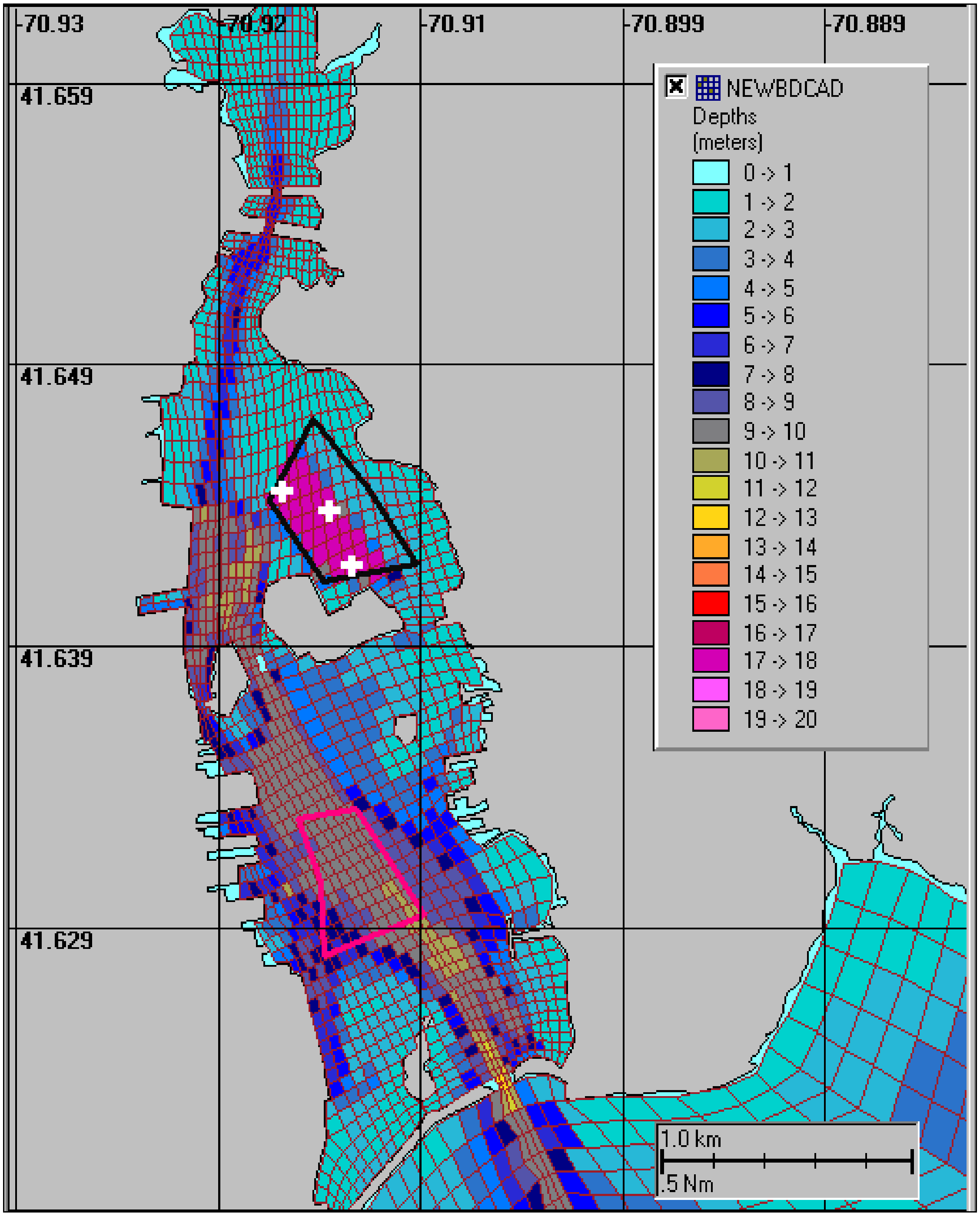


Figure 5-6. Modeled mass load locations (white crosses) used to simulate disposal operations in PIN-CAD site (black polygon), superimposed on bathymetry.

5.3.5 *Other Model Parameters*

Primary physical processes governing the fate and transport of disposed material are advection and diffusion. Advection is due to the currents that are predicted from the hydrodynamic modeling. Diffusion includes horizontal and vertical diffusion that are specified as model inputs.

5.3.6 *BFMASS Modeling Results*

This section documents the results of the fate and transport simulations of contaminants of unsuitable dredged materials disposed at the PIN-CAD site in the Harbor. Simulations were performed using a three-dimensional (7-layer) application of BFMASS. Three different tides (spring, neap and mean tides), and three wind conditions (calm, northwesterly and southwesterly winds) were chosen as representative of the range of likely environmental conditions. All modeled constituents were released at the end of flood portion of the M_2 tidal cycle, so that the subsequent ebb currents transported the constituents in the water column south toward the Hurricane Barrier.

UDM from station NBH-202 was more highly contaminated compared to the other stations. For example, the PCB elutriate concentration was 767 times the U.S. EPA chronic level (U. S. EPA, 2002). This is four times higher than the next highest PCB concentration found at station NBH-207 (located at Fish Island) and 70 times higher than the lowest at station NBH-204. This section documents model results in detail for the worst contaminant case, NBH-202 PCBs, and then presents the results in more generalized format for the rest of contaminants and stations.

Among the nine environmental scenarios, the largest spatial coverage was predicted for neap tides and calm wind conditions. On the other hand, the smallest coverage occurred for neap tides and northwesterly winds. This finding was consistent among the three different release locations in the PIN-Cad cell. Figures 5-7 and 5-8 show the maximum area affected (coverage) due to released NBH-202 PCB as a function of concentration for the neap tide and no wind condition and the neap tide and northwesterly wind condition, respectively. The area of the PIN-CAD is shown for reference as is the U. S. EPA chronic water quality (WQ) concentration for PCB.

Under calm winds (Figure 5-7), the area coverage is always larger than the CAD area for concentrations less than 0.4 μg/L. The coverages at the PCB chronic level (0.03 μg/L) are 1×10^6 m^2 (southeast corner release) and 1.2×10^6 m^2 (center and northwest corner releases), which are between 6 and 7 times larger than the CAD cell area, respectively. The concentrations for an area the same as the CAD site area are 0.42 μg/L, 0.44 μg/L and 0.35 μg/L for a center, northwest and southeast release, respectively. While the calm wind condition simulates very similar coverages for the three release locations (Figure 5-8), a northwest release with northwesterly winds generates the largest coverage and a southeast release yields the smallest coverage (Figure 5-9). Spatial coverage for the 0.03μg/L chronic concentration with wind is 0.3×10^6 m^2, 1.9×10^5 m^2, and 3.3×10^6 m^2 with southeast, center and northwest releases, respectively. The concentrations for areas equivalent to the CAD site area are 0.015 μg/L for a southeast release, 0.035 μg/L for a center release and 0.08 μg/L for a northwest release.

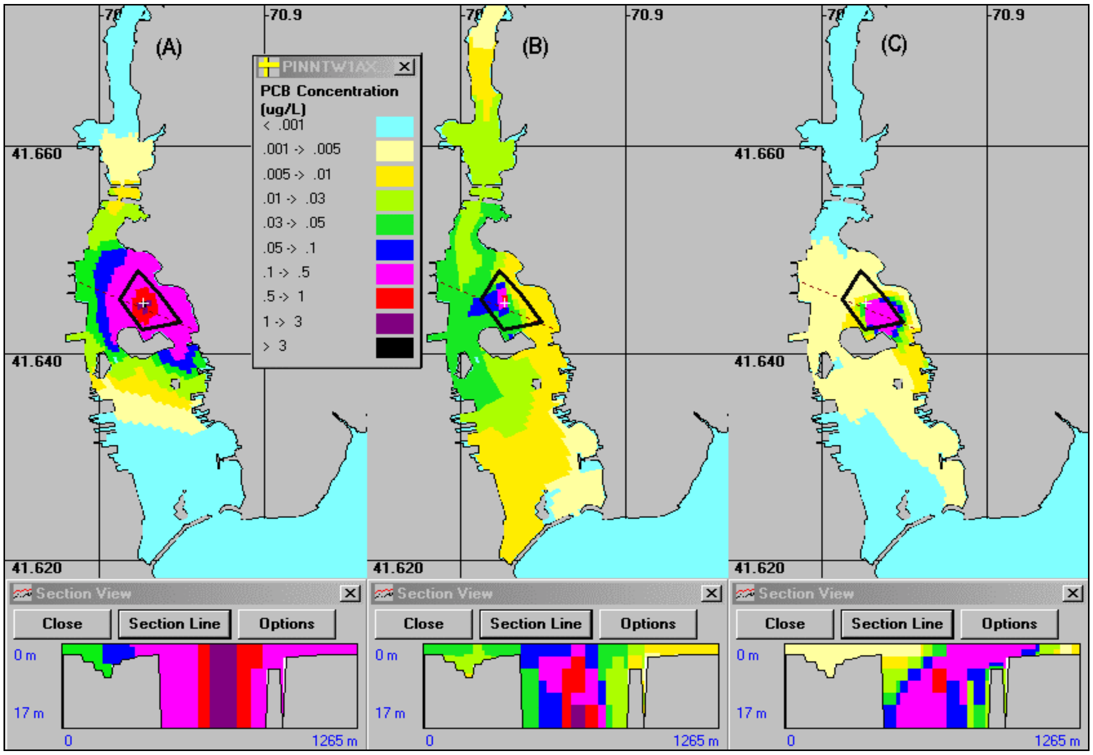


Figure 5-7. Simulated PCB distributions for calm wind (a), southwesterly (b) and northwesterly winds (c). Distributions are shown 1 hour after the final disposal event.

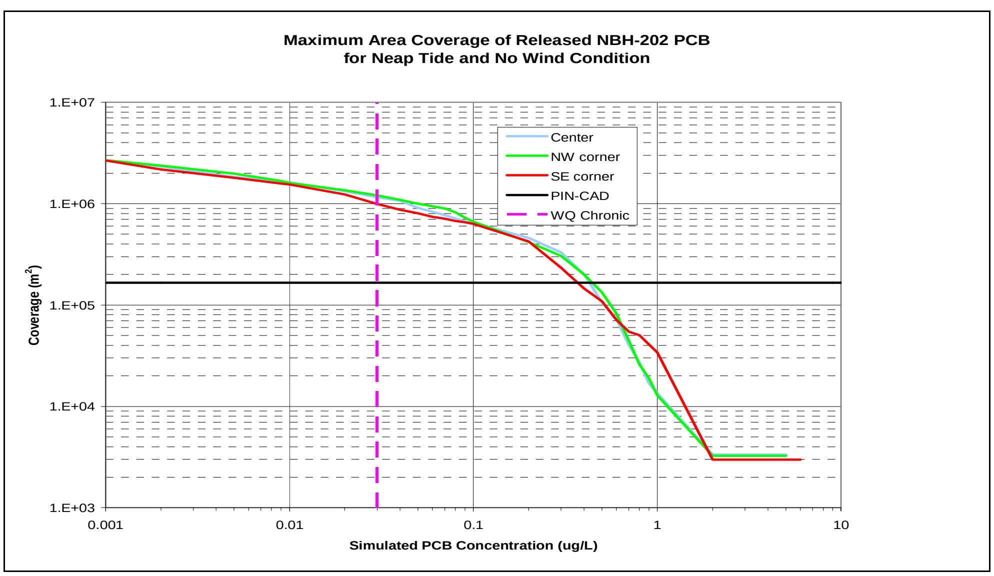


Figure 5-8. Maximum area coverages (y-axis) of PCBs vs. concentrations for neap tides and calm winds for three release sites using the NBH-202 station source strength. The PIN-CAD cell area (1.67×10^5 m^2) is a black horizontal line and the U. S. EPA WQ chronic value for PCB (0.03 µg/L) is a dashed purple vertical line.

According to toxicity tests using sediments from the sampling stations with mysids and sea urchins reported by SAIC (2003), the cause of acute toxicity was the combination of multiple pollutants. For example, half the toxicity to mysids was due to PCBs and the other half was due to a combination of copper and ammonia. From these results, SAIC suggested that a dilution to at least 2.2% of the elutriate concentration would be protective.

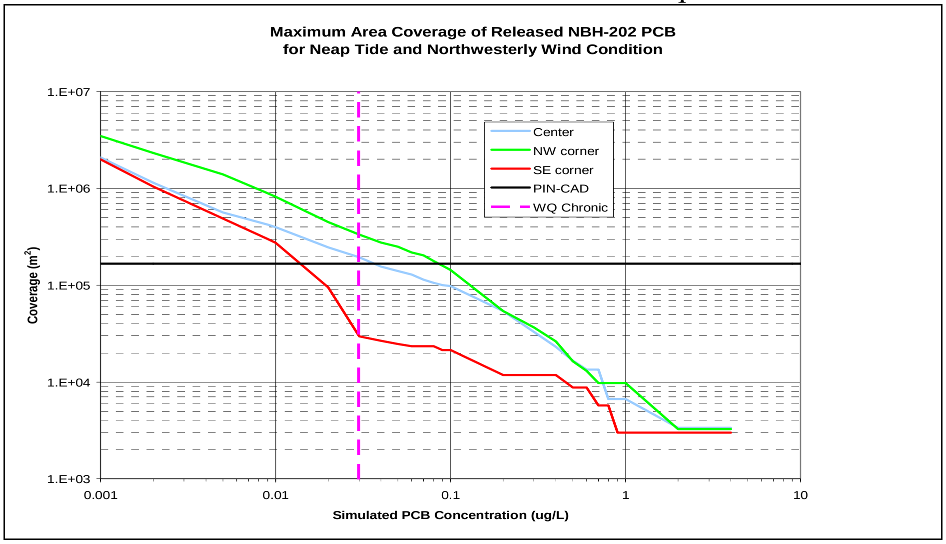


Figure 5-9. Maximum area coverages (y-axis) of PCBs vs. concentrations for neap tides and northwesterly winds for three release sites using the NBH-202 station source strength. The PIN-CAD cell area (1.67×10^5 m^2) a black horizontal line and the U. S. EPA WQ chronic value for PCB (0.03 μg/L) is a dashed purple vertical line.

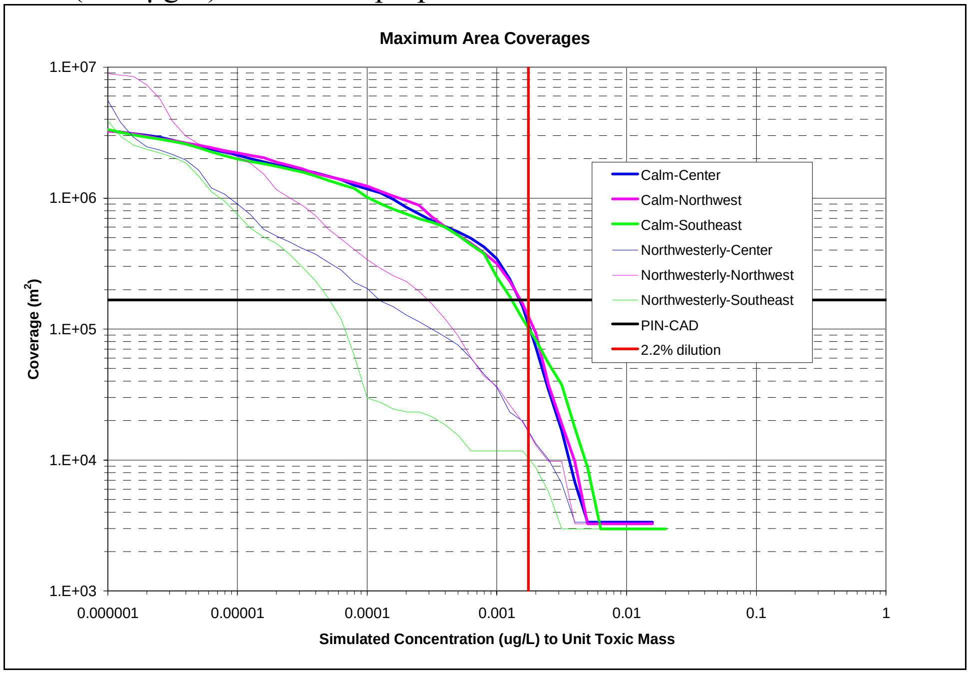


Figure 5-10. Maximum area coverage for released toxic material for calm and northwesterly winds.

Figure 5-10 shows maximum area coverages for a release of 1g of a combination of toxic pollutants. Presented are the coverages for the worst conditions (neap tide and calm wind) and the most favorable conditions (neap tide and northwesterly wind). For both conditions, area coverage for a concentration of 2.2% of the elutriate level was always smaller than the PIN-CAD area. The largest area coverage for the 2.2% elutriate concentration occurred for a northwest release during calm winds, 1.2×10^5 m^2. The smallest coverage for the protective dilution level occurred for a southeast release during northwesterly winds, 1.0×10^4 m^2.

5.4 Summary

The field-obtained elevations and velocities were examined to determine that tides and wind were the primary forces that drove the circulation in New Bedford Harbor. Hydrodynamic simulations were successfully conducted to verify model performance for the period of the field measurement program. Nine basic hydrodynamic conditions were prepared to provide the advection data to the pollutant and sediment transport models based on the combination of three tidal ranges (neap, mean and spring) and three most likely wind conditions (calm, southwesterly and northwesterly directions).

The SSFATE (Suspended Sediment Fate) model was used to simulate TSS (Total Suspended Solid) concentrations due to the proposed excavation of the CAD (Confined Aquatic Disposal) cells and the disposal of dredged material into one of the cells. Resultant TSS distributions showed that combinations of the wind induced circulation and bathymetry played a key role. When the sediment plumes were carried into the deeper sections of the harbor, the duration and size of sediment cloud were more extensive than when the sediment plumes were carried into the shallower sections, where the sediment settled out more quickly.

A series of dissolved phase pollutant fate and transport simulations were performed to estimate the water quality impacts in the water column at north of PIN, using BFMASS (Boundary Fitted Mass Transport Model). Simulations were performed for various pollutant constituents whose elutriate concentrations exceeded the U. S. EPA water quality guidance levels: metals (aluminum, copper, nickel and silver), and polychlorinated biphenyls (PCBs). The model simulated the fate and transport of disposal of dredged material at the PIN CAD site. Disposal operations were assumed to last for 6 days and disposal taking place twice a day following the M_2 tidal cycle. Each release volume of dredged material was assumed to be 1,530 m^3 (2,000 yd^3).

A series of dissolved phase pollutant fate and transport simulations were performed to estimate the water quality impacts in the water column at north of Popes Island, using BFMASS (Boundary Fitted Mass Transport Model). Simulations were performed for various pollutant constituents whose elutriate concentrations exceeded the U. S. EPA water quality guidance levels: metals (aluminum, copper, nickel and silver), and polychlorinated biphenyls (PCBs). The model simulated the fate and transport of disposal of dredged material at the PIN-CAD site (north of Popes Island). Disposal operations were assumed to last for 6 days with disposal taking place twice a day following the M_2 tidal cycle. Each release volume of dredged material was assumed to be 1,530 m^3 (2,000 yd^3).

The BFMASS simulation results indicated that the contaminant distribution patterns in the horizontal and vertical were similar for the three tide ranges. Concentration levels, however, were higher in the near field for neap tides than for spring tides because more energetic currents during the spring tides promote more dispersion and mixing. Different wind conditions resulted in different spatial distribution patterns and coverages. Among the nine environmental scenarios, the largest spatial coverage (area) was predicted for neap tides and calm wind conditions. The smallest coverage occurred for neap tides and northwesterly winds. This finding was consistent among three different release locations in the high capacity PIN CAD Cell 1.

According to toxicity tests using sediments from the NBH-202 station sampled at CAD-CI, the combination of multiple pollutants was the cause of the observed acute toxicity effects. For example, half the toxicity to mysids was due to PCBs and the other half was due to a combination of copper and ammonia. From these results application of the WER developed for water quality thresholds in Section 3.8, concluded a dilution to less than 2.2% of the elutriate concentration would be protective of marine organisms. The model results showed that for any environmental condition, area coverage for a concentration of 2.2% of the elutriate level was always smaller than the PIN-CAD area (1.67×10^5 m^2 [41 ac]). This finding provides confidence that construction of the preferred alternative and related disposal events modeled in this section of the FEIR can be limited to the area of the CAD footprint. Impacts to the vicinity can be managed within the water quality thresholds set by DEP. The largest area coverage (1.2×10^5 m^2 [30 ac]) of the 2.2% elutriate concentration occurred for a release during calm conditions while the smallest coverage (1.0×10^4 m^2 [2.5 ac]) occurred for a release during northwesterly winds. Other sediments with lower elutriate concentrations, and presumably lower toxicity, would affect smaller areas.